Exchange Rates and Monetary Policy with Heterogeneous Agents: Sizing up the Real Income Channel

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- e.g. high MPCs, unequal exposures [Johnson-Parker-Souleles 06, Kaplan-Moll-Violante 18, Auclert 19, ...]

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Exciting literature: [Farhi-Werning, Cugat, De Ferra-Mitman-Romei, Giagheddu, Zhou, Kekre-Lenel, Guo-Ottonello-Perez, ...]

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  - In the paper: similar result for monetary policy shocks
- How large is χ? Low in short run, higher in long run [Ruhl, Boehm-Levchenko-Pandalai-Nayar]

$\rightarrow$ model generates **contractionary depreciation** after capital flow shock

HANK meets Gali-Monacelli

Model overview

- Discrete time, small open economy (SOE) model
  - No aggregate uncertainty + small shocks (first order perturb. wrt aggregates)

- Two goods
  - "Home": H, produced at home. Price P_{Ht} at home, P^*_{Ht} abroad
  - "Foreign": F, produced abroad. Price P_{Ft} at home, $P^*_{Ft} = 1$ abroad
  - Consumed in bundles. Price P_t of bundle at home, $P^*_t = 1$ abroad

- Two classes of agents
  - large mass of foreign households with fixed real C^*
  - mass 1 of domestic households, **subject to idiosyncratic income risk**

Households' consumption behavior

▸ preferences

- Domestic **HA**: **intertemporal problem**

$$\max_{\{c_{it}\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta_i^t \left\{ \frac{c_{it}^{1-\sigma}}{1-\sigma} - v(N_t) \right\}$$

$$c_{it} + a_{it+1} = (1 + r_t^p) a_{it} + e_{it} \frac{W_t}{P_t} N_t \qquad a_{it+1} \geq 0 \qquad C_t \equiv \int c_{it} di$$

  - a_{it} = position in domestic mutual fund

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- Both domestic & foreign have CES bundle, solve **intratemporal problem**

$$C_{Ht} = (1-\alpha) \left(\frac{P_{Ht}}{P_t} \right)^{-\eta} C_t \qquad C_{Ht}^* = \alpha \left(\frac{P_{Ht}^*}{P^*} \right)^{-\gamma} C^*$$

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- Domestic production and market clearing: $Y_t = N_t = C_{Ht} + C_{Ht}^*$

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- Standard nominal wage rigidity [Erceg-Henderson-Levin, Auclert-Rognlie-Straub]

$$\pi_{wt} = \kappa_w \left(\frac{v'(N_t) / u'(C_t)}{\mu_w W_t / P_t} - 1 \right) + \beta \pi_{wt+1}$$

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Prices, nominal rigidities and monetary policy

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- For now, domestic central bank targets CPI-based real interest rate

$$i_t = r_t + \pi_{t+1}$$

- Mutual fund and foreign agents trade two types of assets:
  - shares in home firms with price $v_t = (v_{t+1} + \text{div}_{t+1})/(1 + r_t)$
  - nominal home & foreign bonds in zero net supply

Financial markets

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- Mutual fund & foreigners invest freely in all assets, equalizing $\mathbb{E}$ returns
    - UIP condition:

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- Without agg. uncertainty, portfolios indeterminate $\Rightarrow$ assume 100% equity
  - study optimal portfolio in alternative complete-market HA model

Benchmark model calibration

details

- Calibrate to a typical emerging economy such as Mexico
- Set $\alpha = 0.40$ to match import share of output in 2019 and balanced trade
- HA: β heterogeneity to match Peruvian data on MPCs [Hong 2020]
- EIS $\sigma^{-1} = 1$
- Allow for general substitution elasticities η, γ for now.

Response to exchange rate shocks

Setup

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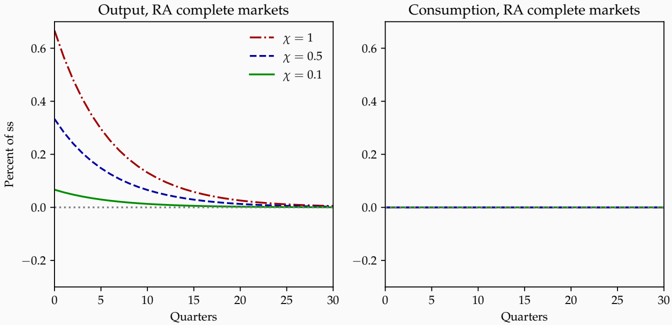
  - $Q_t \uparrow$ (real depreciation), $\frac{P_{Ht}}{P_t} \downarrow$ and $\frac{P_{Ht}}{\mathcal{E}_t} \downarrow$
- Use good market condition to study effect on output:

$$Y_t = (1-\alpha)\left(\frac{P_{Ht}}{P_t}\right)^{-\eta} C_t + \alpha\left(\frac{P_{Ht}}{\mathcal{E}_t}\right)^{-\gamma} C^*$$

Textbook RA complete markets model

- In **RA** : complete markets + r constant $\Rightarrow C_t = C$
- Only channel: **expenditure switching** with trade elasticity $\chi \equiv \eta(1-\alpha) + \gamma$
  - home and foreign households substitute towards cheaper home goods



(i_t^* shock of quarterly persistence $\rho = 0.85$ and impact effect of 1% on Q.)

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$$\frac{W_t}{P_t}N_t = \frac{1}{\mu}\frac{P_{Ht}}{P_t}Y_t \qquad \text{div}_t = \left(1 - \frac{1}{\mu}\right)\frac{P_{Ht}}{P_t}Y_t$$

  - **Real income channel** $\rightarrow$ lower value of goods sold (P_H) relative to bought (P)
  - **Multiplier channel** $\rightarrow$ higher production (Y)

Neutrality result for $\chi = 1$

Theorem

$$\chi = 1 \qquad \Rightarrow \qquad d\mathbf{Y}^{HA} = d\mathbf{Y}^{RA}$$

Heterogeneity is ***irrelevant*** *for output effect of exchange rate*

- **Multiplier channel** undoes **real income channel**, $\frac{P_{Ht}}{P_t} Y_t$ = const
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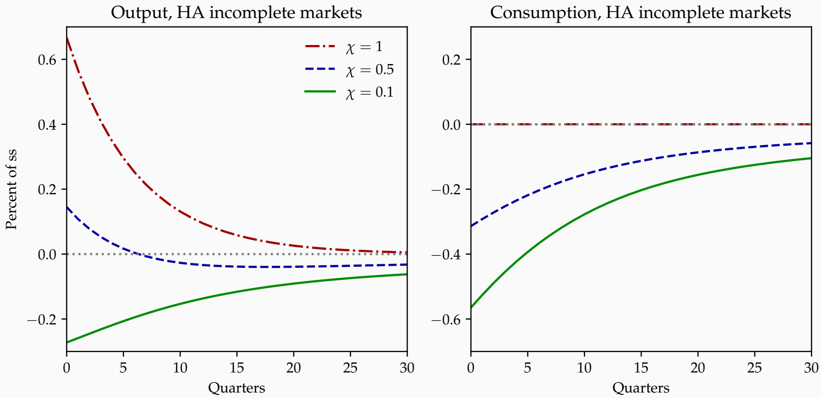
  - Households pay more for consumption, but work more because of the boom
- More generally, for $d\mathbf{Q} \geq 0$, can show $d\mathbf{Y}^{HA} < d\mathbf{Y}^{RA}$ if and only if $\chi < 1$.

Contractionary devaluations in output for low χ

- With χ small, **HA** model can generate **contractionary devaluations**!
  - Boom in exports does not offset change in relative prices anymore



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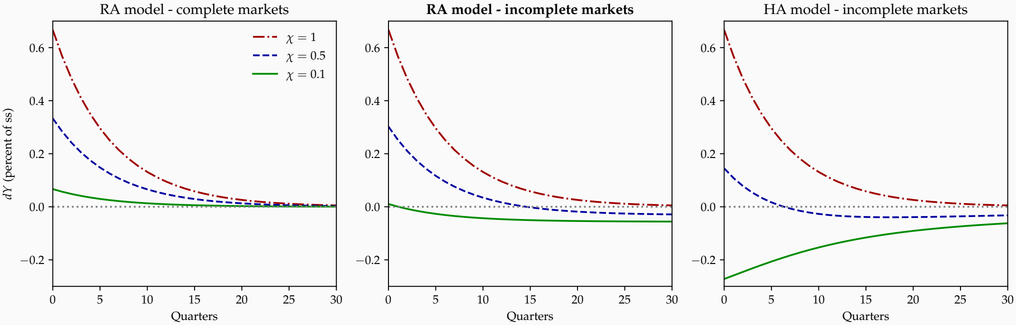
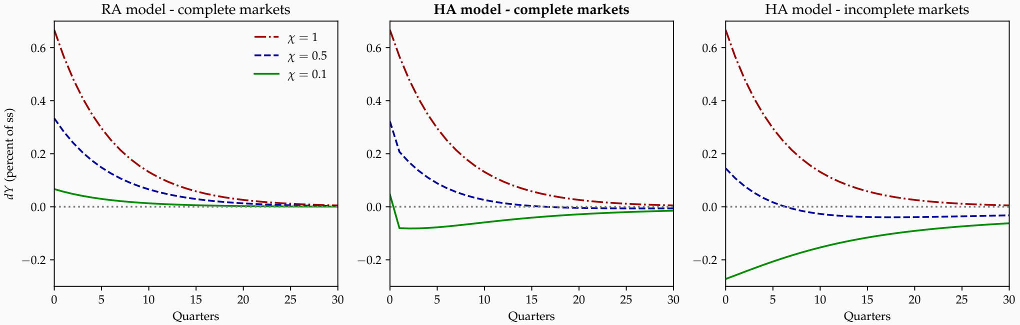
- Middle panel shows *dY* in **RA model with incomplete markets**
    - Small contraction because of low MPCs: heterogeneity quantitatively critical



- Middle panel shows dY in **HA model with complete markets**
  - Small contraction because of hedging: incomplete market also quant. critical



Quantitative model with dynamic trade elasticity

Quantitative model outline

details

- In simple model, trade elasticity χ was critical. What is it?
  - Macro time-series literature $\rightarrow \chi$ is low (< 1)
  - Trade literature (usually from cross-section) $\rightarrow \chi$ is high (> 3)
- Build Calvo model of **delayed substitution** consistent with evidence Details
  - χ is small in the short run, and large in the long run [Boehm-Levchenko-Pandalai-Nayar 20]

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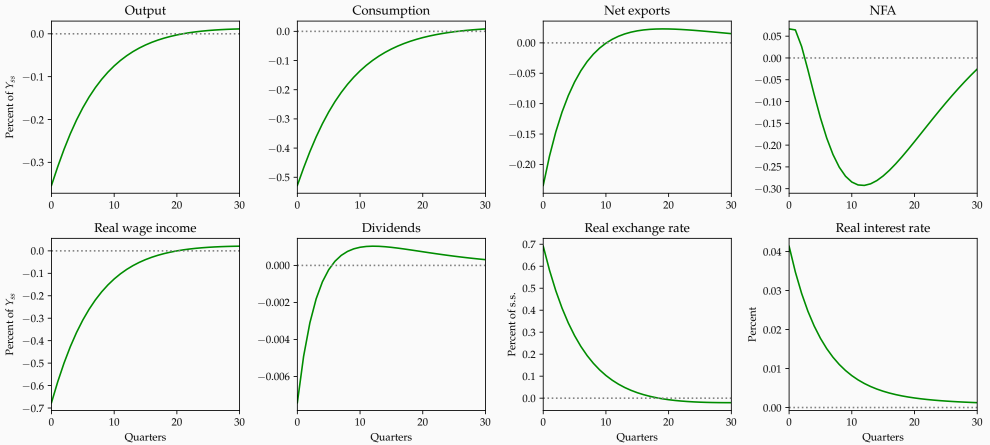
  - χ is small in the short run, and large in the long run [Boehm-Levchenko-Pandalai-Nayar 20]
- Also add quantitative bells and whistles to model
  - Price rigidity in addition to wage rigidity + dollar currency pricing
  - Taylor rule for monetary policy
  - Nonhomotheticities in consumption, heterogeneous incidence of agg. shock

Effects of devaluation shocks in quantitative model

other factors

- Substitution delayed enough that capital outflow shocks are contractionary



Conclusion

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HA + NK-SOE $\Rightarrow$ real income channel

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- contractionary devaluations for plausibly delayed adjustment
- In paper: analytics + implications for monetary policy

Preferences

◂ back

- In baseline, consumption c_{it} aggregates H and F with elasticity η,

$$c_{it} = \left[(1-\alpha)^{\frac{1}{\eta}} \left(c_{iHt}\right)^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}} \left(c_{iFt}\right)^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}$$

and preferences across goods j produced in countries k are

$$c_{iHt} = \left(\int_0^1 c_{iHt}(j)^{\frac{\epsilon-1}{\epsilon}} dj \right)^{\frac{\epsilon}{\epsilon-1}} \quad c_{iFt} = \left(\int_0^1 c_{ikt}{}^{\frac{\gamma-1}{\gamma}} dk \right)^{\frac{\gamma}{\gamma-1}} \quad c_{ikt} = \left(\int_0^1 c_{ikt}(j)^{\frac{\epsilon-1}{\epsilon}} dj \right)^{\frac{\epsilon}{\epsilon-1}}$$

with $\epsilon > 1$, $\gamma > 0$ and $\eta > 0$. Budget constraint:

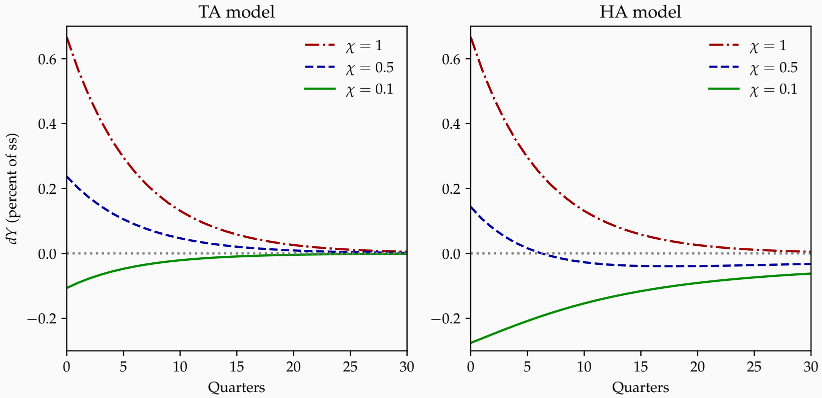
$$\int_0^1 P_{Ht}(j)\, c_{iHt}(j)\, dj + \int_0^1 \int_0^1 P_{kt}(j)\, c_{ikt}(j)\, dj dk + a_{it+1} \leq \left(1 + r_t^p\right) a_{it} + e_{it} \frac{W_t}{P_t} N_t$$

- Demand for good j in country k by consumer i:

$$c_{ikt}(j) = \alpha \left(\frac{P_{kt}(j)}{P_{kt}} \right)^{-\epsilon} \left(\frac{P_{kt}}{P_{Ft}} \right)^{-\gamma} \left(\frac{P_{Ft}}{P_t} \right)^{-\eta} c_{it}$$

Two-agent model

back



The “stealing demand from the future” effect

◂ back

- The effect comes from a **current account deficit** after monetary easing:
    1. Real income effect: import prices rise
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[McKay Wieland 2020, Caballero Simsek 2020, Mian Straub Sufi 2021]

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... but one **big difference**: monetary easing here can have **negative NPV**

$$\text{Present value }(d\mathbf{Y}) < 0 \qquad \Leftrightarrow \qquad \chi < 1 - \alpha$$

Quantitative model: additional elements

back

1. Nonhomothetic Stone-Geary to capture heterogeneity in real income effect

$$C_t = \left((1-\alpha)^{\frac{1}{\eta}} C_{Ht}^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}} \left(C_{Ft} - \underline{c_F} \right)^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}}$$

2. Realistic passthrough of exch. rate to domestic & foreign consumer prices
    - Add domestic price rigidities

$$\pi_{Ht} = \kappa_H \left(\frac{\mu_H W_t / Z_t}{P_{Ht}} - 1 \right) + \beta \pi_{Ht+1}$$

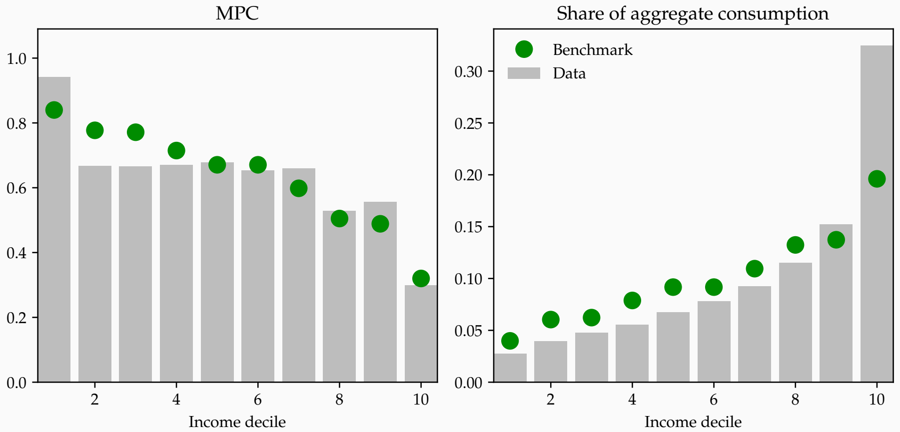
    - Add flexibility of dollar export prices

$$\pi_{Ht}^* = \kappa_X \left(\frac{P_{Ht} / \mathcal{E}_t}{P_{Ht}^*} - 1 \right) + \beta \pi_{Ht+1}^*$$

    - Allow foreign retailers to repatriate profits from dollar sales
3. Allow for currency mismatch in NFA ($f_Y \equiv$asset-liability mismatch/GDP)
    - Debt held by households via mutual fund, or by government and then rebated

Benchmark model fit

back



back to sec 1 back to sec 2

Parameter	Benchmark	Quantitative	Parameter	Benchmark	Quantitative
σ	1	1	μ	1.03	1.028
ψ	2	2	s.s. nfa	0	0
η	$\frac{\{0.1,0.5,1,2-\alpha\}}{2-\alpha}$	4	σ_e	0.6	0.6
γ	$=\eta$	$=\eta$	ρ_e	0.92	0.92
θ	n.a.	0.987	θ_w	0.95	0.95
β	0.954	0.953	θ_p	0	0.75
Δ	0.06	0.067	θ_x	n.a.	0.66
α	0.4	0.323	θ_l	0	0
$\underline{c}$	0	0.114	ϕ	n.a.	1.5

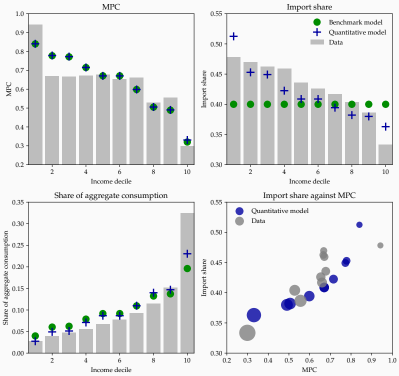
Calibration targets

back to sec 1 back to sec 2

Moment	Data	Benchmark model	Quantitative Model
Average MPC	0.632	0.636	0.637
Std of MPC	0.152	0.151	0.149
Average tradable share	0.400	0.400	0.400
Std of tradable share	0.042	n.a.	0.042

Calibration outcomes

back to sec 1 back to sec 2



Delayed substitution model

- Ratio $x = \frac{C_H}{C_F}$ is a state variable, updated a la Calvo with parameter θ
- Static outcome ($\theta = 0$)

$$x_t = \frac{\alpha}{1-\alpha}\left(\frac{P_{Ht}}{P_{Ft}}\right)^{-\eta}$$

- Dynamic ($\theta > 0$) outcome with log utility [general case in paper]

$$\begin{aligned} d\log x_t^* &= -\eta(1-\beta\theta)d\log\frac{P_{Ht}}{P_{Ft}} + \beta\theta d\log x_{t+1}^* \\ d\log x_t &= (1-\theta)d\log x_t^* \qquad\qquad + \theta d\log x_{t-1} \end{aligned}$$

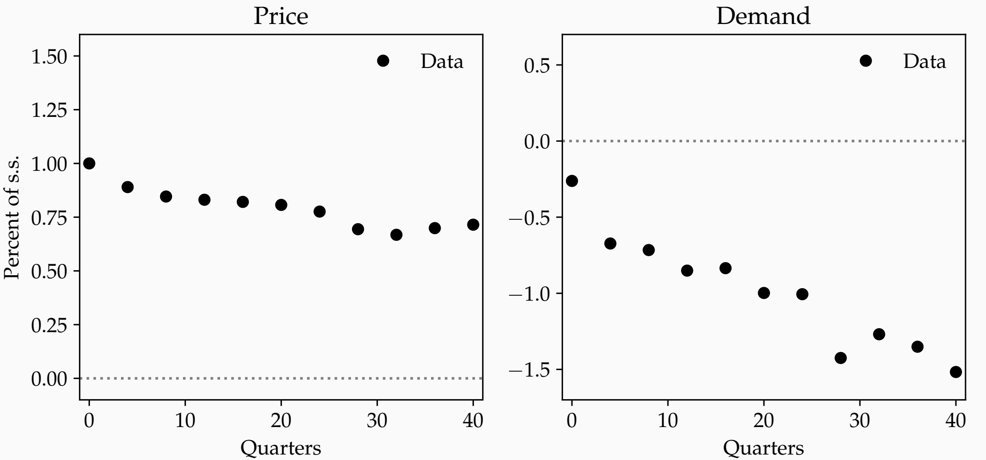
  Long-run elasticity is η, short-run is $< \eta$, depends on shock duration

- Same assumption for γ (exports slow to adjust)

Calibration of η, γ and θ

back

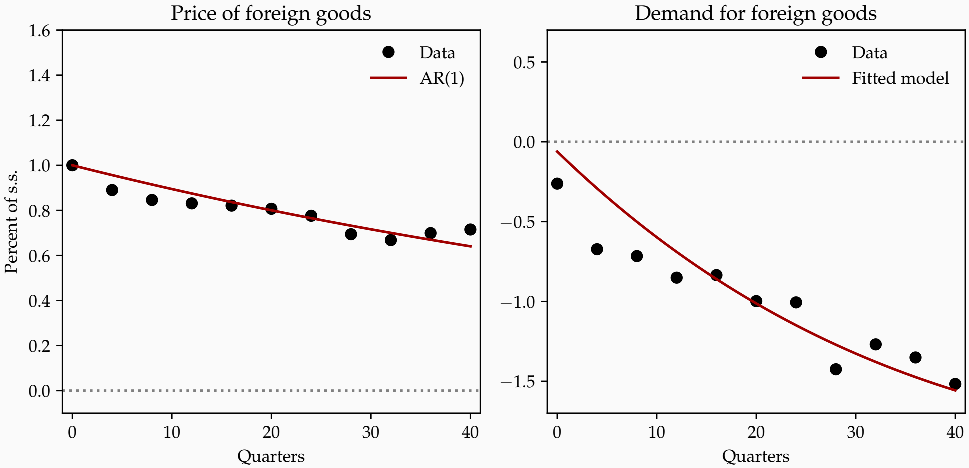
- Use tariff change evidence in Boehm, Levchenko, and Pandalai-Nayar



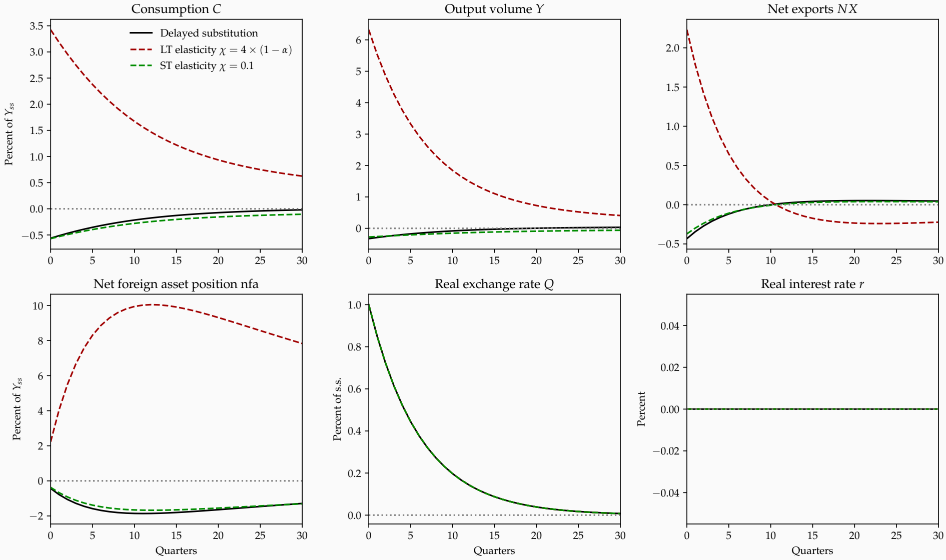
Calibration of η, γ and θ

back

- Use tariff change evidence in Boehm, Levchenko, and Pandalai-Nayar



Quantitative model behaves like a low-elasticity model



Comparative statics

◂ back

	Bench.	Low α	High *MPC*	Full DCP	Low passthru	Homothetic	High ST elast.
dY_0	- 0.36	- 0.27	- 0.40	- 0.31	- 0.09	- 0.32	- 0.30
PDV of dY	- 2.03	- 2.38	- 1.15	- 1.25	- 1.01	- 1.51	- 0.25

(Response to i_t^* shock of quarterly persistence $\rho = 0.8$ and impact effect of 1% on Q.)

back

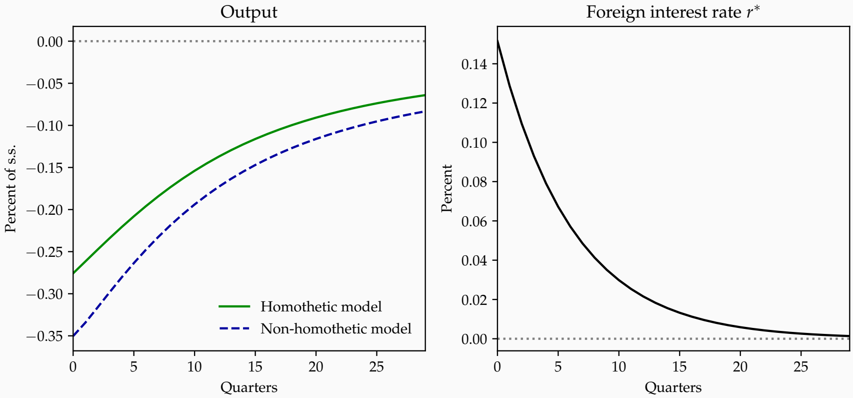
Assuming a gross currency debt position in the NFA of 50% of annual GDP:

			Government		
	Benchmark	Mutual fund	lump-sum	prop tax	+ deficit-fin.
dY_0	- 0.36	- 0.41	- 0.71	- 0.63	- 0.46
PDV of dY	- 2.03	- 2.86	- 3.18	- 3.17	- 3.21

(Response to i_t^* shock of quarterly persistence $\rho = 0.8$ and impact effect of 1% on Q.)

Amplification from non-homothetic demand

back



Amplification from currency mismatch on balance sheet

back